GMW

USER'S MANUAL

MODEL: MC- XYZT, MOTION CONTROL

For GMW Model 5201 Projected Field Electromagnet

File No: GMW_MOTION_CONTROL_VXM_V2_August19-05.doc Revision Date: August 19, 2005

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Email: sales@gmw.com Web site: http://www.gmw.com

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Section 1
SPECIFICATIONS

General:

Controller Package:	EIA 19” rack mounting cabinet, 3U high
Controller Dimensions:	447.00 mm (wide) x 146.00 mm (high) x 425.00 mm (deep) (17 5/8” x 5 3/4” x 16 3/4”)
Controller Weight:	14.2 kg (31.5 lb.)
Power Supply:	CONDOR, HCC15-3-A+
Power Requirements:	115ACV/60Hz, 1.5A 220ACV/50Hz, 1.0A
Motor Controller:	VELMEX Stepping Motor Controller Model VXM-2 One controller has provision for controlling two motors One or two controllers fitted.
Computer interface:	GPIB

Motion Stages:

X: Slave Velmex Controller Motor 1. Max range of 200 mm.
Y: Slave Velmex Controller Motor 2. Max range of 200 mm.
Z: Optional stage. Master Velmex Controller Motor 2. Max range of 30 mm.
T: Master Velmex Controller Motor 1. Angle about Z axis. Max range of 360 Deg.

Motion Stage Weight (without magnet): 9.5 kg (21.0 lb.) with X, Y, T stages
13.0 kg (29.0 lb.) with X, Y, Z, T stages

CAUTION: The rotary stage does not have limit switches build in. User should be cautious about the angle position. More than a 360 degree rotation will cause damage to the cable and water hose to the magnet. It is recommend that after powering up the controller, user manually adjust the rotary stage to zero degree while watching the cables and water hose. Manual reset Angle counter afterwards

Motion stage T is always provided. X, Y, Z motion stages are optional.

Section 2
SYSTEM DESCRIPTION

The system consists of the following main components.

-2 VELMEX Stepping Motor Controllers. Model: VXM-2. Each VXM-2 can control up to two motors. Provision of controlling total four motors. One Motor Controller is configured as Master controller, the other Motor Controller is configured as Slave Controller. The two motors connected to master controller are recognized as motor 1 and 2 by the system, the two motors connected to slave controller are recognized as motor 3 and 4.

-Power supply. CONDOR model HAA15-0.8-A+, dual adjustable outputs. Provide electrical power both for the motor controllers and GPIB/RS232 converter.

-National Instruments GPIB/RS232 converter. Convert RS232 interface at VXM-2 to GPIB interface.

-Linear stages provide X, Y and Z motion.

-Rotary stage provides angle motion.

-Software provided on CD.

- National Instruments NI-GPIB driver CD.
- GMW Motion Control Software CD
  - -Executable file.
  - -Installer files.
  - -PDF manual (This document).
  - -LabVIEW Source Code.

Section 3
SYSTEM REQUIREMENTS

-AC line voltage: 115-220ACV/50-60Hz

-Computer: Windows2000/NT/XP, GPIB interface card installed, CD-ROM for installing software.

-LabVIEW 7.0 or later for running, viewing and modifying software. Not require if the executable version of Motion Control software provided is used.

-LabVIEW Run Time Engine 7.0 for running executable version of the software. Executable version Motion Control software does not require LabVIEW but requires LabVIEW Run Time Engine 7.0. It is included in the Motion Control software CD.

Section 4
INSTALLATION

4.1 –Verify the GPIB and required drivers are installed in the computer.

4.2 – Verify the AC voltage selector on the rear panel of the Motion Control set to the correct line voltage.

4.3 – Connect GPIB cable from computer to the Motion Control Interface.

4.4 – Connect power cord to the Motion Control Interface.

4.5 – Connect cables to all the motors.

Each stage has two cables. One is for the motor; one is for the limit switches. Both cables need to be connected. Connect Rotary stage to Master Motor 1, X stage to Slave Motor 1, Y stage to Slave Motor 2. Connect optional Z stage to Master Motor 2.

4.6 – Power on computer.

4.7 – Power on Motion Control Interface.

The Found New Hardware wizard will find the NI-GPIB/RS232 converter automatically. Follow the instruction to install the necessary driver into computer. Please refer to the document provided on the GPIB driver CD for more information.

4.8 – Install LabVIEW7 software.

Skip this step if LabVIEW7 was already installed or it is intended to use executable version of Motion Control software.

Section 4

INSTALLATION

4.9 – Verify the hardware is installed correctly.

Double click the icon of Measurement & Automation on the desk top to open MAX. Go to My System>>Devices and Interfaces>>GPIB0. Right click on the right side window. Select Scan for Instruments. If an entry shows an instrument at address 1, the device is installed correctly. GPIB address was preset to 1 at factory. User can change the GPIB address if needed. Refer to the documentation on the GPIB driver CD from National Instruments for more information about how to change GPIB address.

4.10 – Install Motion Control software.

The Motion Control software CD includes both source VI and executable version. Source VI is the source code for LabVIEW. LabVIEW 7.0 or later is required for viewing, modifying and running VI. Executable version is a stand alone version. It does not require LabVIEW to run but requires LabVIEW Run Time Engine7.0. LabVIEW Run Time Engine 7.0 is included in the Motion Control software CD.

Close the MAX and any other programs that may be open. Insert Motion Control software CD. The installation should start automatically. If the installation does not start automatically, run Setup.exe from the CD. Setup.exe is in the folder Installer on the CD. After installing Motion Control software, it will prompt user if LabVIEW RunTime Engine 7.0 will be installed.

4.11 – Restart computer.

Section 5
SOFTWARE DESCRIPTION

5.1 – Starting and Stopping the Software

To open the program, go from Start>>Programs>>GMW Motion Control>>Motion Control V2

Click on the white arrow button on the top of the screen to start the software.

Click Stop button or use <Esc> key to stop the software.

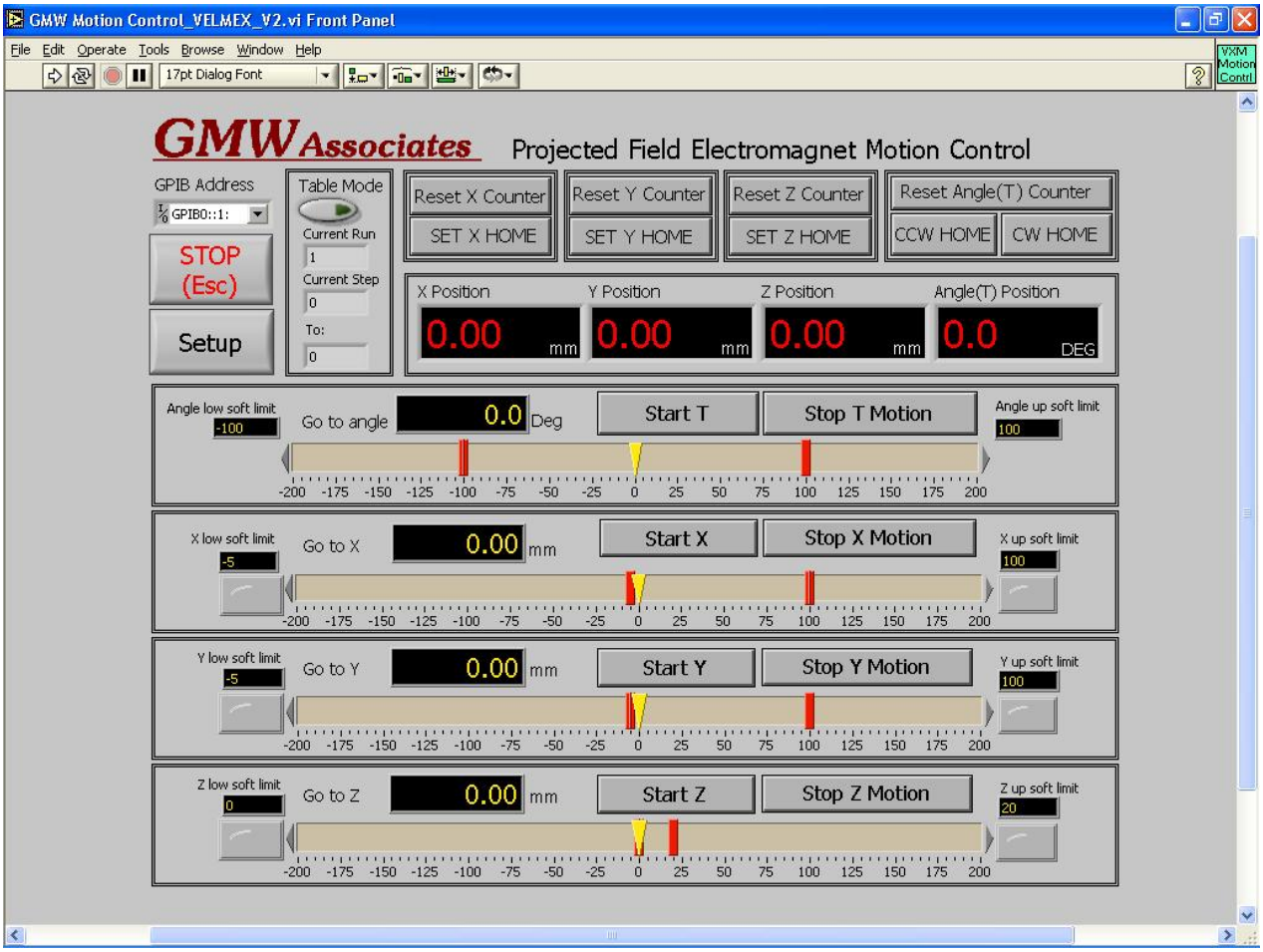


Figure 1.Main control window

5.2 – GPIB Address Selection

Select GPIB address. Default GPIB address is 1.

Section 5
SOFTWARE DESCRIPTION

5.3 – Setup

Set up the parameters for the software. When click the button of SETUP, a Setup window will appear.

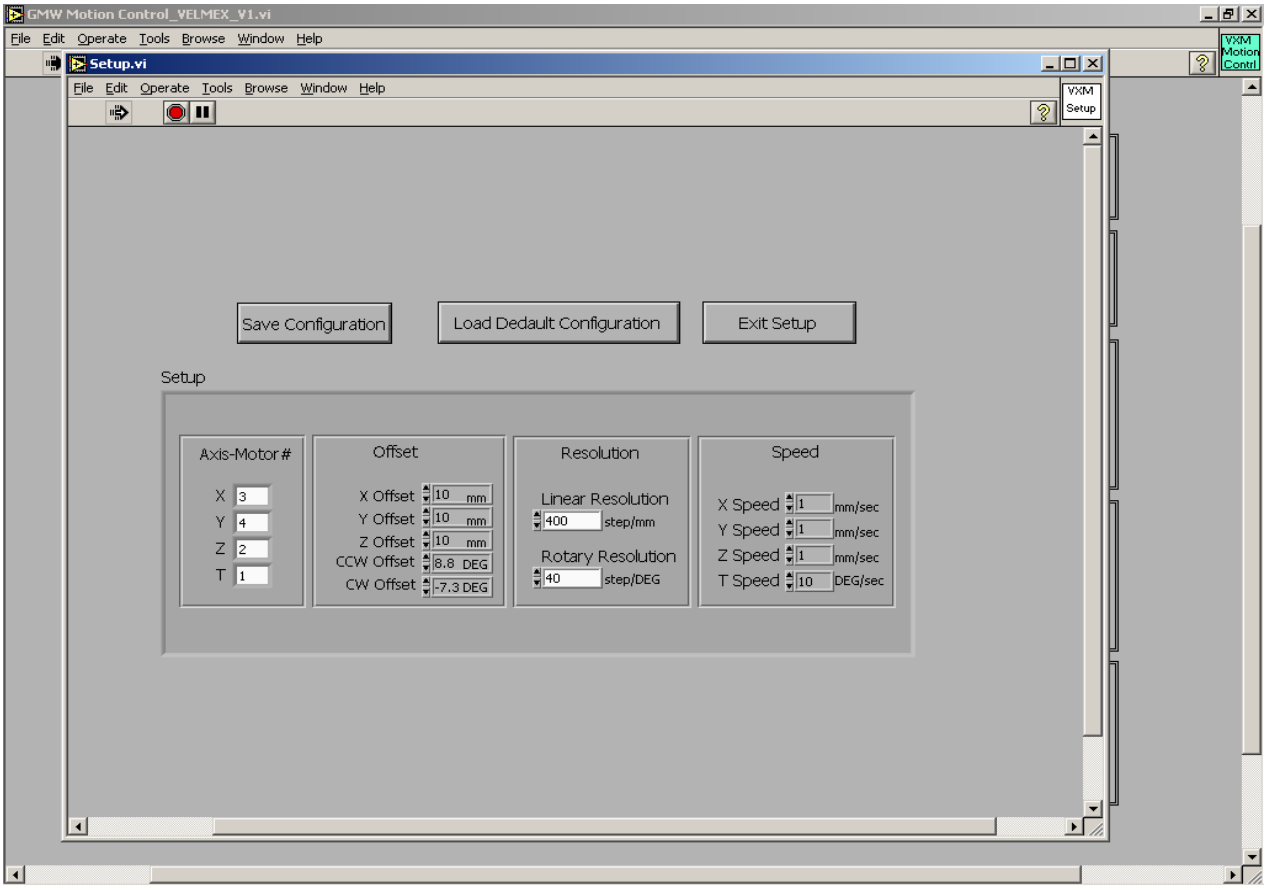


Figure 2. Setup Window

5.3.1 – Save Configuration. Will save the current configuration. The software will use the saved configuration next time it starts if the configuration was saved. If the configuration was not saved, the software will still use the current configuration but will use the previously saved configuration next time the software starts.

5.3.2 – Load Default Configuration. Will load the default settings.

5.3.3 – Exit Setup. End the setup process and close the setup window.

5.3.4 – Axis-Motor#. Assign the individual stage to the motor control port on the motor controller. X, Y and Z are for linear stages, T is for rotary stage. By default, X is motor 3 (Slave motor1), Y is motor 4 (Slave motor 2), T is motor 1 (Master motor 1), Z is motor 2 (Master motor 2).

5.3.5 – Offset. Used for setting the home position. X, Y and Z Offset are the linear offset positions from the low limit switch where the step motor counter will be set to zero. CW and CCW Offset are the offsets from the home switch to zero degree position. CW is the clockwise offset; CCW is the counter-clockwise offset.

5.3.6 – Resolution. Linear resolution is 400 steps per 1 mm. Rotary resolution is 40 steps per 1 degree. Resolution settings are determined by the motor and motion stages. User should not change the resolution settings unless the motion stages are changed.

5.3.7 – Speed. Define the speed. The default linear speed is 1mm/second for X and Y, 0.5mm/second for Z. The default rotary speed is 10 degree/second.

5.4 – Table Mode.

The Table mode LED OFF indicates the software run at manual mode. The Table mode LED ON indicates the software run at table mode.

Click Table Mode LED, a Table Mode Setup window will appear.

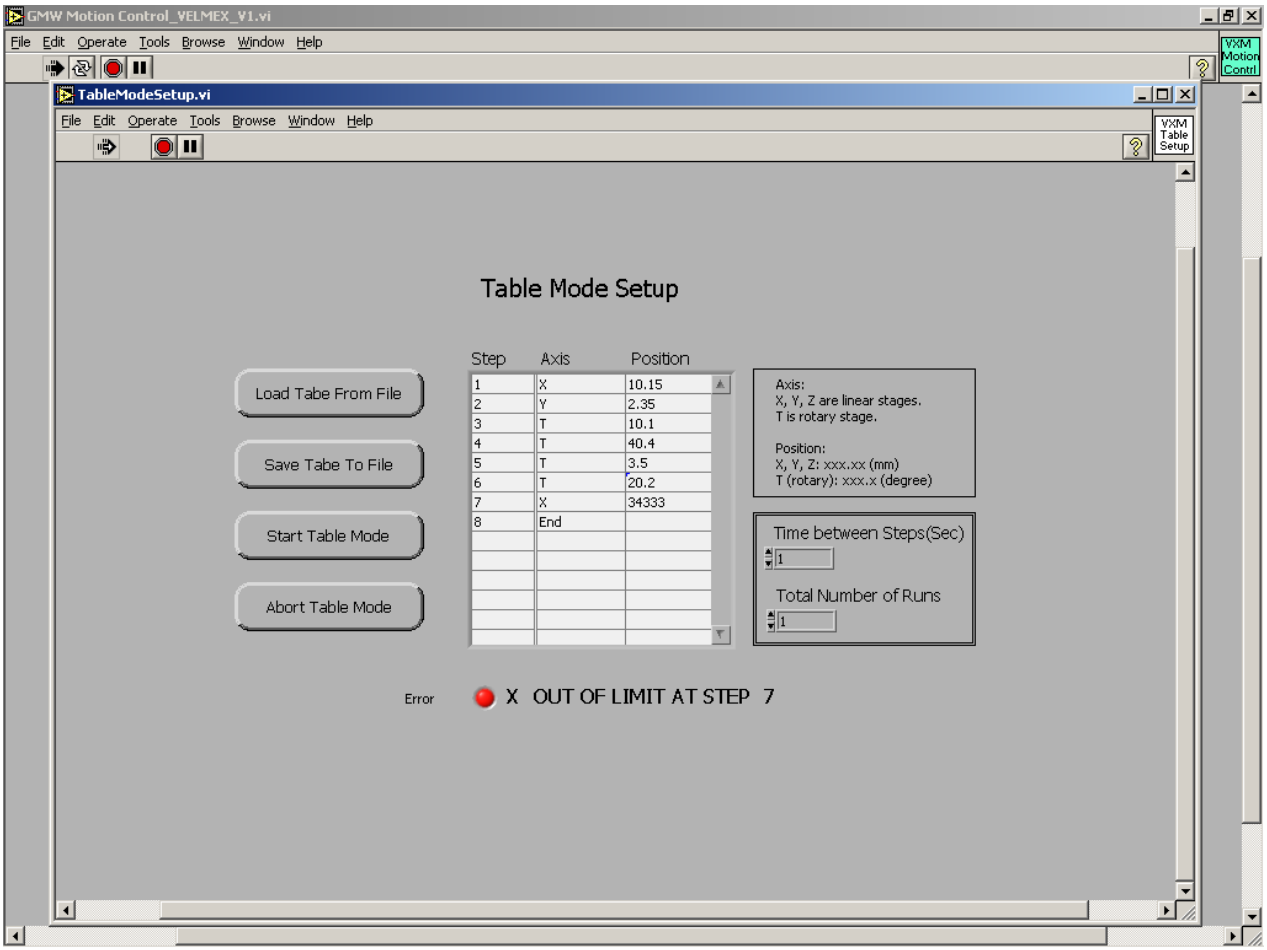


Figure 2. Table Mode setup window

Section 5
SOFTWARE DESCRIPTION

When running at Table mode, user can either manually enter a table or load a table from a file. The first column is for Step index. The second column of the table is the axis intended for moving. X, Y and Z are for linear stages accordingly. T is for rotary stage. The third column is the position intended to move to. The unit for linear stage is mm. The unit for rotary stage is degree. The table is ended by the word "END". The word "END" is used to indicate the end of the table.

User can construct a table using EXCEL or any word processing software. The table file must have the same structure as the table shown but without the column for Step index. It consists two columns, one for axis, and one for position. The table ended by the word "END". The column uses Tab as delimiter.

5.4.1 – Load Table From file. Will prompt user for loading a pre-saved table file.
5.4.2 – Save Table to File. Will prompt user for file name and location to save current table on the screen to a file for later use.
5.4.3 – Start Table Mode. Close the Table Setup window and start running the software at Table mode using the table on the screen.
5.4.4 – Abort Table Mode. Close the Table Setup window and return to the software to manual mode.
5.4.5 – Error LED. Indicates if the table includes value out of the software limit set by user. When out of limit error occurs, the software will not go to table mode unless the error is corrected or the Table mode is aborted.
5.4.6 – Time Between steps (Sec). Specify how many seconds will pause between steps.
5.4.7 – Total Number of Runs. Specify how many times user wants repeat the table.

5.5 – Set X, Y, Z Home

Home position is the position the counter of stepping motor controller is zero. Each time the stepping motor power off/on, the counter is set to zero, regardless the physical position of the stages. Before use, user need to establish the home position either using the Set Home buttons or Reset Counter buttons.

Click one of the buttons Set X Home, Set Y Home, Set Z home. The linear stage will move to the lower end of the station. When the limit switch is hit, the motion will stop, the stage will move back the distance defined as X, Y, Z Offset at the Setup window. The counter of motor controller, X, Y or Z, will set to zero accordingly.

5.6 – Set CCW, CW Home

Click one of the buttons CCW Home, CW Home. The rotary stage will move either counter-clockwise (CCW) or clockwise (CW) towards 0 degree. It will rotate back 25 degrees (1000 steps) and goes to the 0 degree again. CCW and CW offset is the distance between the point Home switch is activated and 0 degree. CCW and CW offset is defined within Setup window.

CAUTION: The rotary stage does not have limit switches build in. User should be cautious about which direction to set Home. More than a 360 degree rotation will cause damage to the cable and water hose to the magnet. It is recommend that after powering up the controller, user manually adjust the rotary stage to zero degree while watching the cables and water hose. Manual reset Angle counter afterwards.

Section 5
SOFTWARE DESCRIPTION

5.7 – Reset X, Y, Z and Angle counter

Used for manually reset the counter of the controller. The current position will be 0 mm for linear stages, 0 degree for rotary stage after Reset Counter button being clicked.

5.8 – X, Y, Z and Angle position

Read back the current position of the stages. X and Y positions are displayed after the moving is stopped. Angle position and Z position can be displayed during the moving.

5.9 – Start Rotation, Start X, Y, Z

Manually start the motion to the position defined by user. The position is entered either typing in the position box or using the slide. The position can be positive or negative.

5.10 – Stop Rotation, Stop X, Y, Z Motion

Stop the motion during the scan.

5.11 – Software Limit for Angle, X, Y and Z

Set up by either typing in the two boxes or using the slides. The software limits define the minimum and maximum target position. The software limits also define the minimum and maximum target position can be used in table mode. At manual mode, target position over the software limits is ignored and the limit value is used instead. At table mode, target position over software limit will cause an error; user needs to change the target position or abort the table mode to proceed. Default volumes of software limit can be changed within Setup Windows.

5.12 – Limit LED

If the linear stages reached one of the limit switch mounted at the linear stages on both ends, the motion will stop, the Limit LED will lit, indicating the physical limit is reached.

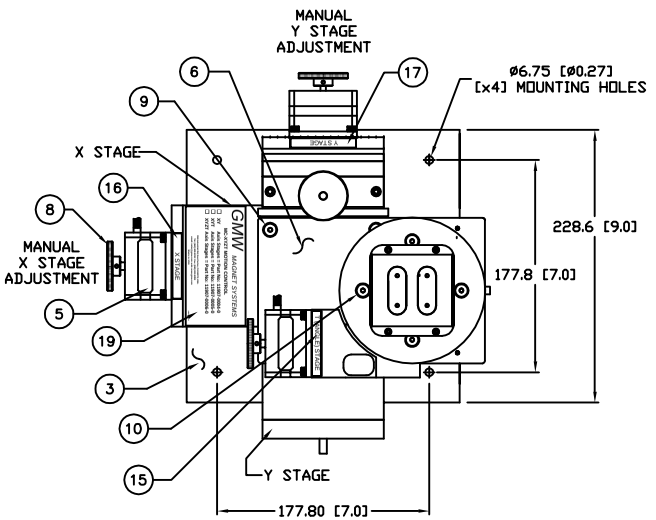
CAUTION: Limit switch only installed on linear stages. There is no limit switch on the rotary stage for over rotation protection. More than 360 degree rotation will cause damage to the cables and water hose to the magnet.

Section 6.1
APPENDIX - DRAWINGS

6.1 - Drawings

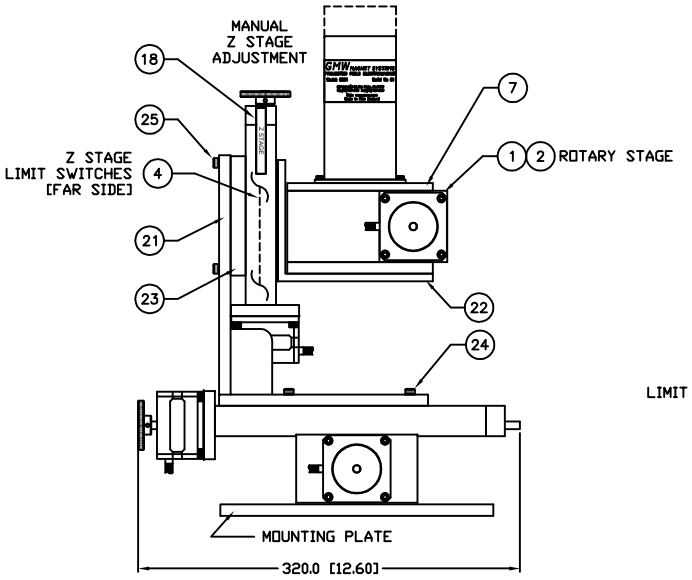
11907-0006-0_Rev_A – Mechanical Assembly for XYZT
11902520_Rev A – Mechanical Assembly for XYT
11902530_Rev A – Electrical Assembly
11907-0001-0_Rev_A – Controller Assembly

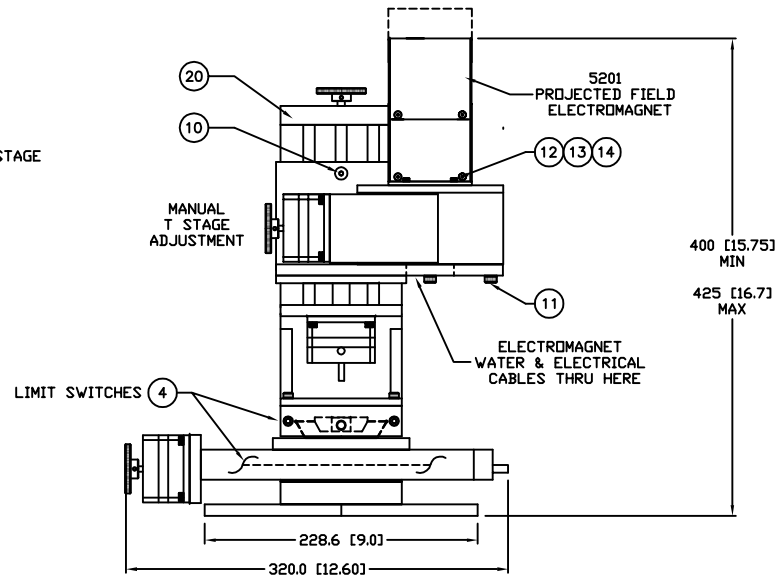
REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		01/17/05	G.DOUGLAS



NOTE

1. ZERO REFERENCE SWITCH FITTED TO ROTARY STAGE. NOMINAL RANGE 0 to 360 DEGREES.
2. ADJUSTABLE LIMIT SWITCHES FITTED TO X and Y STAGES. NOMINAL RANGE X,Y =+/− 20mm, Z =+/− 12.5mm
3. STEPPER MOTORS FITTED TO X,Y,Z and ROTARY STAGE MANUAL STAGE ADJUSTMENT ON EACH STEPPER MOTOR.
4. SEE DWG NO 12907−0003−0 AND 12907−0004−0 FOR ADDITIONAL MOUNTING HOLES REQD ON Y AND Z STAGES.





ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
25	4		SHCS, 10−32 x 1 1/8" S/S	
24	4		SHCS, 10−32 x 5/8" S/S	
23	2	17907−0010−0	SPACER BAR, Z STAGE	
22	1	17907−0009−0	ADAPTER PLATE, Z STAGE to ROTARY STAGE	
21	1	17907−0008−0	ADAPTER PLATE, Z STAGE to Y STAGE	
20	1	MA Series	6" LINEAR STAGE, Std 1mm leadscrew VELMEX Part: MA4006K1−S4	2
19	1	10907−0015−0	LABEL, IDENTIFICATION	
18	1	10907−0014−0	LABEL, Z AXIS	
17	1	10907−0012−0	LABEL, Y AXIS	
16	1	10907−0011−0	LABEL, X AXIS	
15	1	10907−0013−0	LABEL, T AXIS [ANGLE]	
14	4		WASHER, INTERNAL LOCK M3 S/S	
13	4		WASHER, FLAT M3 S/S	
12	4		SHCS M3 x 8 S/S	
11	3		SHCS 1/4 x 3/4" S/S	
10	6		SHCS FLAT HD, 10−32 x 1/2" S/S	
9	4		SHCS FLAT HD, 10−32 x 5/8" S/S	
8	4	CN11−5	HANDWHEEL, ALUMINUM BERG	
7	1	17907−0007−0	ADAPTER PLATE, ROTARY STAGE/MAGNET	
6	1	17907−0006−0	ADAPTER PLATE, T STAGE [ROTARY]	
5	4	5−0981	STEPPER MOTOR, Double Shaft VELMEX	3
4	3	3−8515	LIMIT SWITCH, ADJUSTABLE VELMEX	2
3	1	MAXY Series	XY TABLE, Std 1mm leadscrew 9" Stages VELMEX Part: SPMAXY4009K1−S4	2
2	1	3−934R	ZERO REFERENCE SWITCH, VELMEX	1
1	1	B4836TS	ROTARY STAGE, 36:1 gear ratio VELMEX Part No: 3−812 0.025°/step	1

PARTS LIST

DRAWN G.DOUGLAS 01/17/05
CHECK
ENGINEERING
DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)

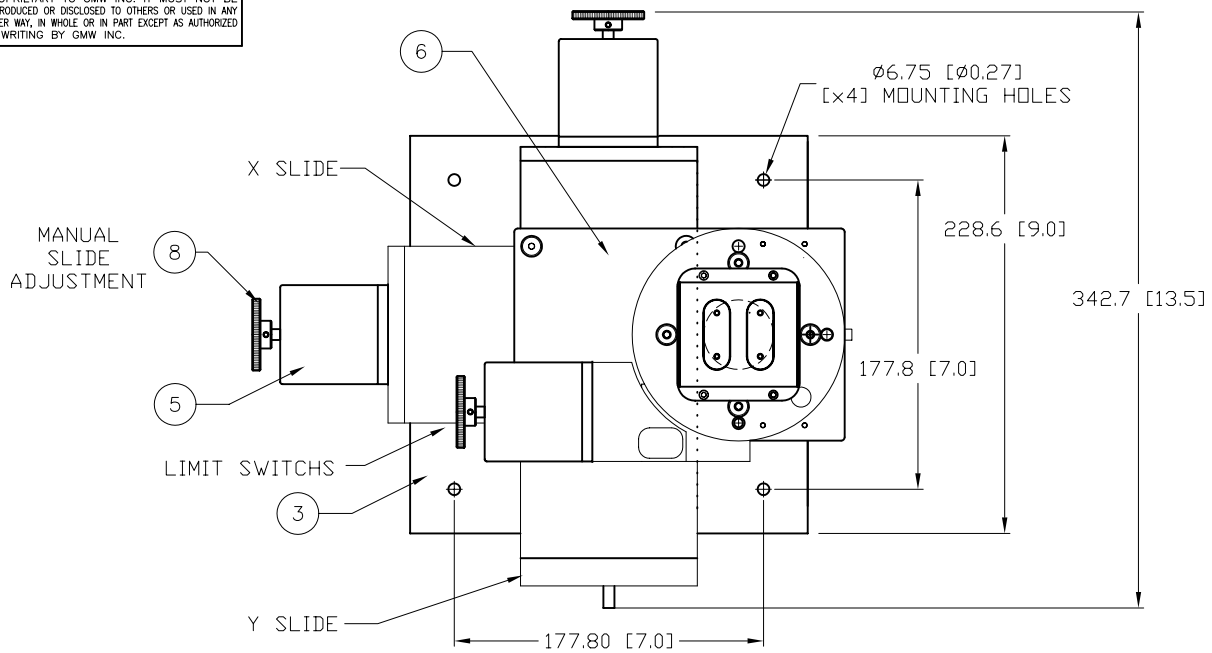
	INCHES	mm
LINEAR X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±0.5	±0.5
FINISH	63	1.6

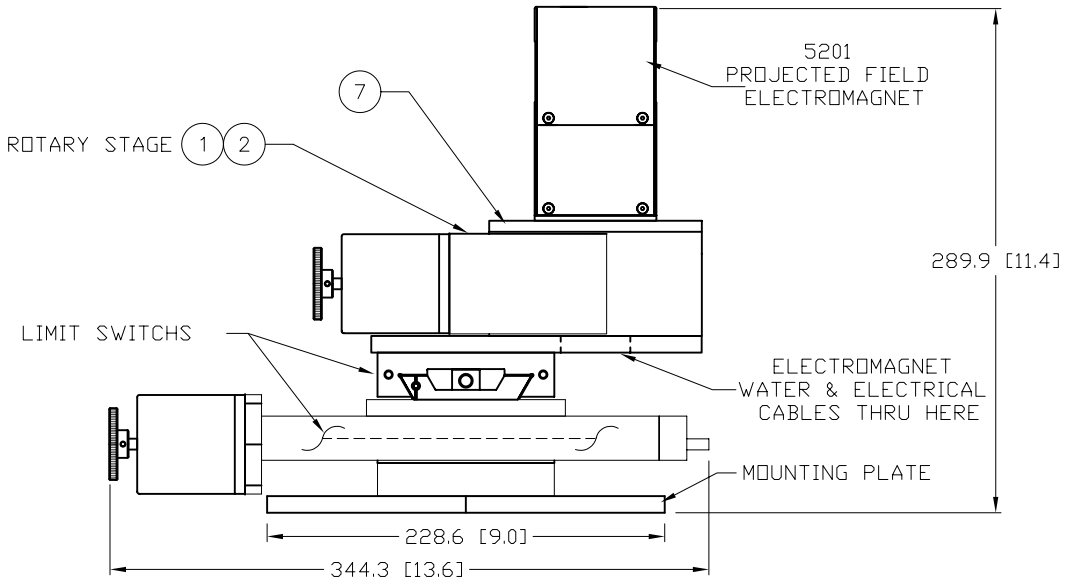
NEXT ASSY | SYSTEM
SOFTWARE AUTOCAD 2000
THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802−8292. Fax: (650)802−8298.

TITLE
XYZT TABLE ASSEMBLY
MOTION CONTROL

SIZE A1 | DRAWING NO. 11907−0006−0 | REV A
SCALE 1:2 | WT kg | SHEET 1 OF 1





REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE			

DRAWING NOT RELEASED–UPDATED JAN 29, 2004

NOTE

1. ZERO REFERENCE SWITCH FITTED TO ROTARY STAGE. NOMINAL RANGE 0 to 360 DEGREES.
2. ADJUSTABLE LIMIT SWITCHES FITTED TO X and Y SLIDES. NOMINAL RANGE +/– 20mm
3. STEPPER MOTORS FITTED TO X,Y and ROTARY STAGE MANUAL SLIDE/STAGE ADJUSTMENT ON EACH MOTOR.

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
8	3	CN11–5	HANDWHEEL, ALUMINUM BERG	
7	1	17906240	ADAPTER PLATE, ROTARY STAGE/MAGNET	
6	1	17906230	ADAPTER PLATE, XY TABLE/ROTARY STAGE	
5	3	4–9821	STEPPER MOTOR, Double Shaft VELMEX	3
4	2	3–8515	LIMIT SWITCH, ADJUSTABLE VELMEX	2
3	1	MAXY Series	XY TABLE, Std 1mm leadscrew VELMEX Part: MAXY4009K1–S4–BK [black anodize]	2
2	1	3–934R	ZERO REFERENCE SWITCH, VELMEX	1
1	1	B4836TS	ROTARY STAGE, 36:1 gear ratio VELMEX Part No: 3–812 0.025°/step [black anodize]	1

PARTS LIST

DRAWN G.DOUGLAS	DATE 10/25/04	DO NOT SCALE FROM DRAWING DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)	GMW 955 Industrial Rd, San Carlos, CA 94070 Tel: (650)802–8292. Fax: (650)802–8298.	
CHECK	DATE			
ENGINEERING	DATE		TITLE MOTION CONTROL MECHANICAL ASSEM	
NEXT ASSY	SYSTEM	THIRD ANGLE PROJECTION	SIZE A2	DRAWING NO. 11902520 REV –
SOFTWARE AUTOCAD 2000			SCALE 1:1	WT kg SHEET 1 OF 1

LINEAR	INCHES	mm
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X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63	1.6

DRAWING NOT RELEASED–UDATED JAN 28, 2005

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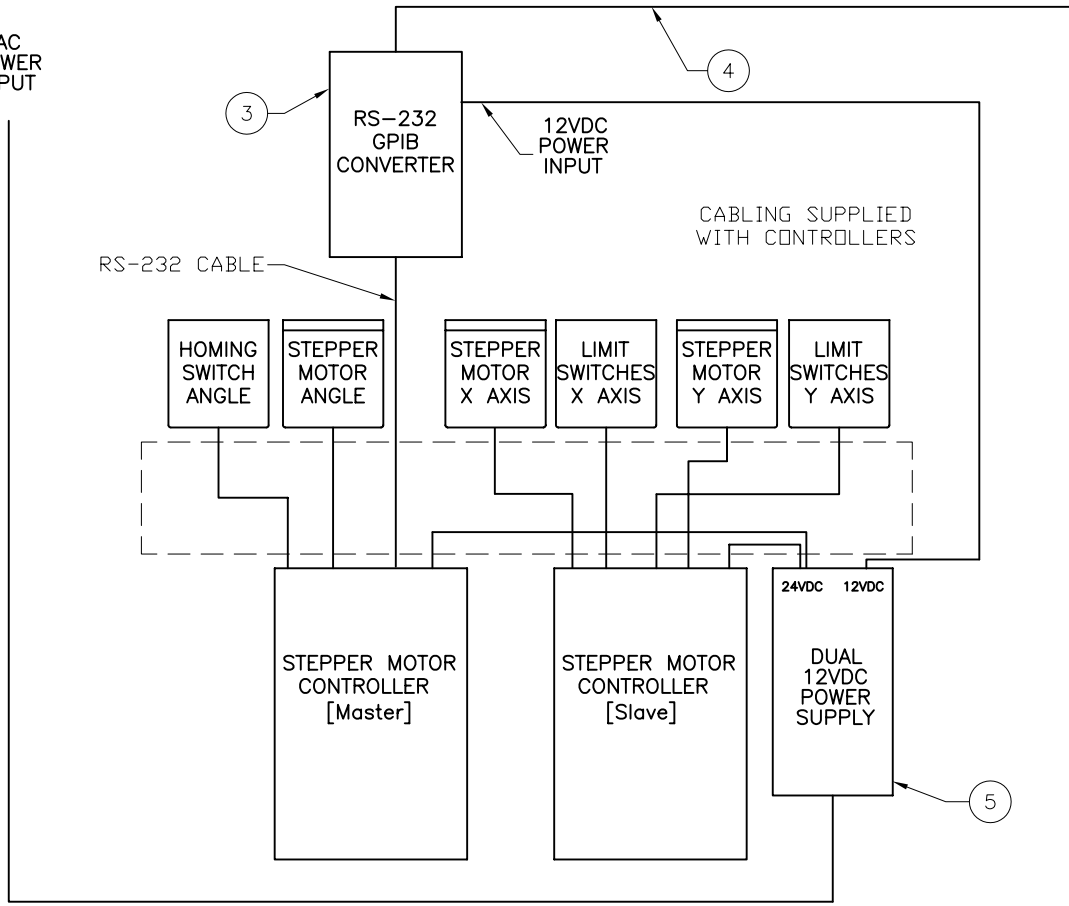
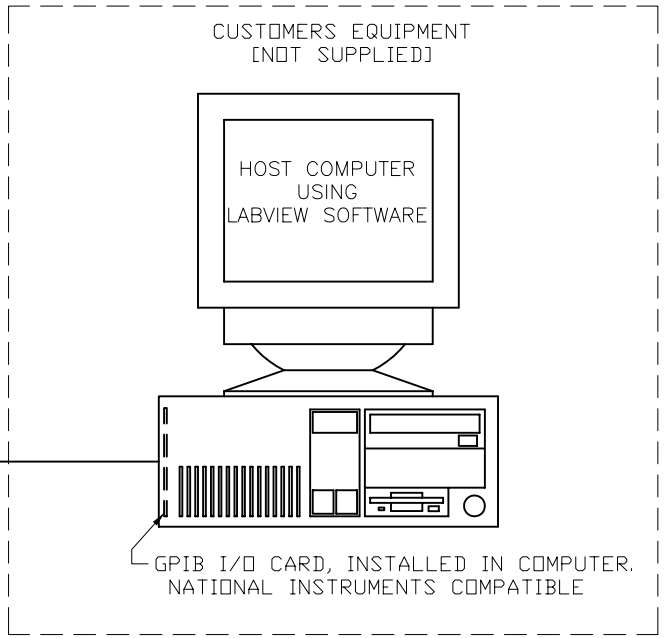
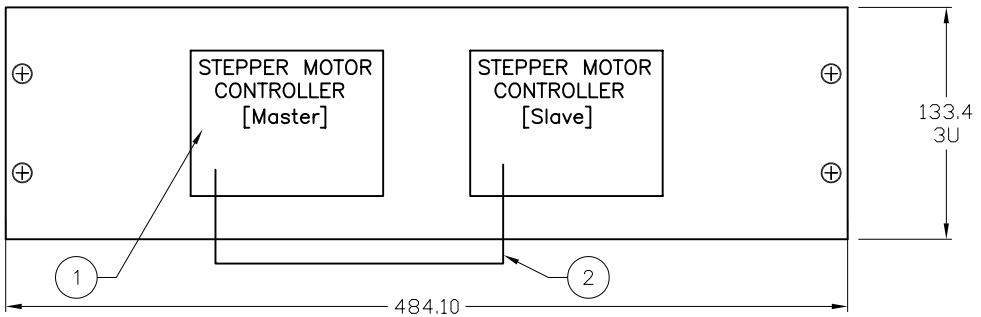
A	RELEASE			







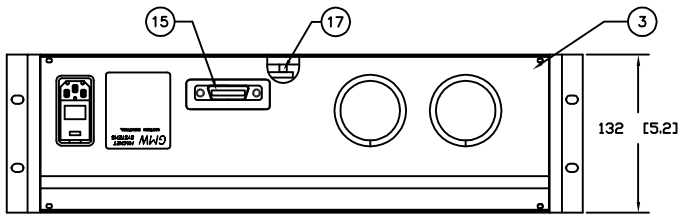
ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
5	1	HCC15-3A+	POWER SUPPLY, DUAL 12V@3.4A, CONDOR	
4	1		CABLE, RS-232	
3	1	776899-Y1	RS-232/GPIB CONVERTER NAT INSTR	
2	1	4-2122	CABLE, BUSSING VELMEX [connects two controllers together]	
1	2	4-2102	CONTROLLER, STEPPER MOTOR VELMEX [for 2 motors, one at a time]	

PARTS LIST

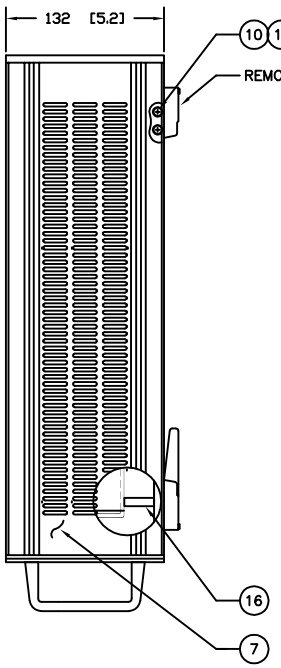
DRAWN G.DOUGLAS	DATE 01/01/01	DO NOT SCALE FROM DRAWING	GMW
CHECK	DATE	DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)	955 Industrial Rd, San Carlos, CA 94070
ENGINEERING	DATE	LINEAR: INCHES / mm; X.XXX ±.005 / ±0.03; X.XX ±.01 / ±0.1; X.X ±.03 / ±0.3; X ±.06 / ±1; DEG. ±.5 / ±0.5; FINISH 63 / 1.6	Tel: (650)802-8292. Fax: (650)802-8298.
			TITLE: MOTION CONTROL ELECTRICAL ASSEM
NEXT ASSY	SYSTEM	THIRD ANGLE PROJECTION	SIZE A2 / DRAWING NO. 11902530 / REV —
SOFTWARE AUTOCAD 2000			SCALE / WT kg / SHEET 1 OF 1

REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		01/17/05	G.DOUGLAS

REAR VIEW

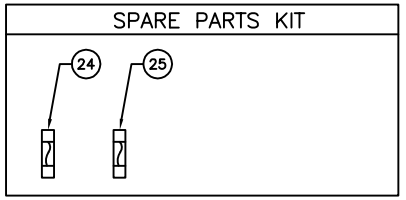


SIDE VIEW

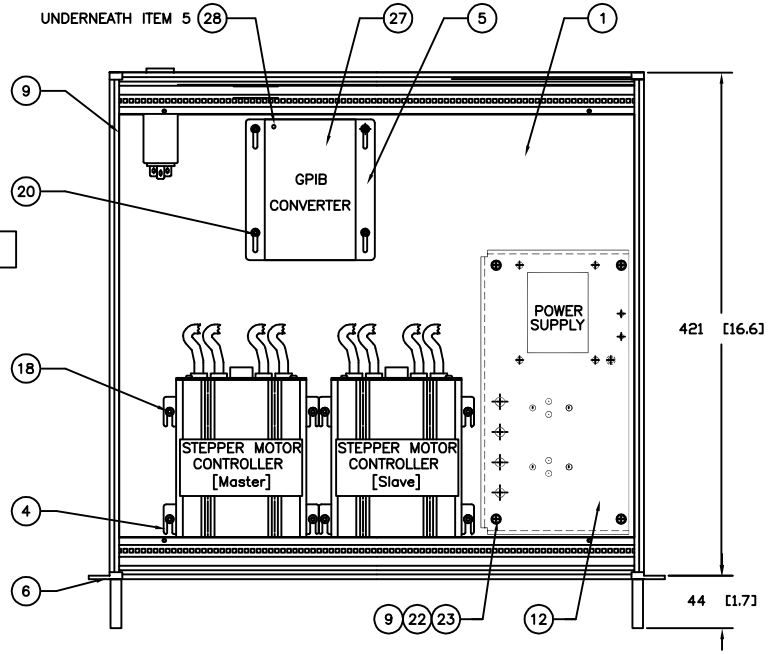


FOR POWER CORDSET SUITABLE FOR OTHER COUNTRIES
NOTE: AC POWER CORDSET SHOWN FOR US/CANADA. SEE TABLE

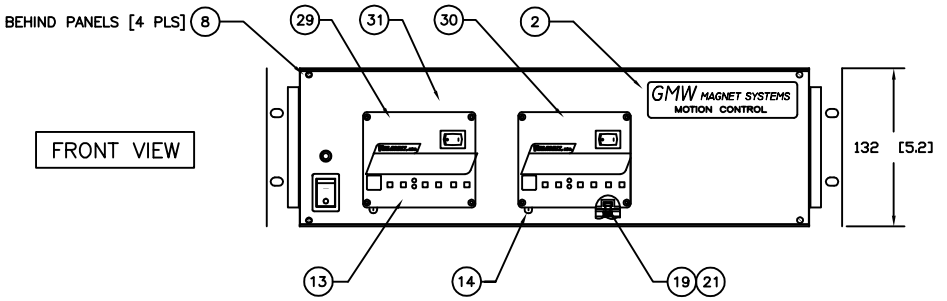
SPARE PARTS KIT



TOP VIEW



FRONT VIEW



AC POWER CORDSETS		
COUNTRY	RATING	MANUFACTURER AND PART NUMBER
USA/CANADA	115V/13A	PANEL COMPONENTS PART NO 70403020305
EUROPE	250/16A	PANEL COMPONENTS PART NO 86235000
UK/INDIA	230V/13A	PANEL COMPONENTS PART NO 86395090
ARGENTINA	220V/10A	PANEL COMPONENTS PART NO 86390010
SWITZERLAND	230V/10A	PANEL COMPONENTS PART NO 86396000
ITALY	230V/10A	PANEL COMPONENTS PART NO 86394000

PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
31	1	10907-0006-0	LABEL, CONTROLLER	
30	1	10907-0005-0	LABEL, SLAVE CONTROLLER	
29	1	10907-0004-0	LABEL, MASTER CONTROLLER	
28	4		SCREW, 4-40 x 3/16" PAN HD S/S	
27	1	776898-01	GPIB CONVERTOR, DC INPUT NAT INSTR	
26	1	70403020305	POWER CORDSET, PANEL COMPONENTS	
25	2	239002	FUSE LINK 2.0 A SLO BLO LITTLEFUSE	
24	2	239001	FUSE LINK 1.0A SLO BLO LITTLEFUSE	
23	8		WASHER, M4 INTERNAL LOCK S/S	
22	8		WASHER, M4 FLAT S/S	
21	8		NUT, HEX M4 S/S	
20	4		SCREW, M3 x 16 PAN HD S/S	
19	8		SCREW, M4 x 8 PAN HD S/S	
18	12		SCREW, M4 x 12 PAN HD S/S	
17	4	RN-4-250A	SPACER, 6.35 x 6.25 NYLON SPC	
16	4	222-503	SPACER, M4 x 25 BRASS R-S	
15	1	CIB24XC	GPIB PLUG EXTENDER L-COM [normal entry]	
14	1	4-2122	CABLE, BUSSING, VELMEX	
13	1	4-2102	MOTION CONTROLLER, VELMEX	
12	1	HCC15-3A+	POWER SUPPLY, DUAL 12V@3.4A, CONDOR	
11	12	1904-12	SCREW, M4 x 10 LOW PROFILE HD, ELMA	
10	6	63-027	BASE PLATE, ELMA	
9	1	63-172	EARTHING KIT, ELMA	
8	4	63-068	TAPPED STRIP 2 X 6, M3 HOLES ELMA	
7	1	14Y135-10	COVER PLATE KIT GREY, ELMA	
6	1	14B035	CASE, RACK MTG 3U [with handles] ELMA	
5	1	17907-0005-0	GPIB CONVERTER MOUNTING PLATE	
4	4	17907-0004-0	CONTROLLER MOUNTING BARS	
3	1	11907-0003-0	BACK PANEL ASSEMBLY	
2	1	11907-0002-0	FRONT PANEL ASSEMBLY	
1	1	17907-0003-0	BASE PLATE	

DRAWN G.DOUGLAS 01/17/05
CHECK
ENGINEERING
NEXT ASSY
SYSTEM
SOFTWARE AUTOCAD 2000
DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)
LINEAR: INCHES / mm
X.XXX ±.005 ±0.03
X.XX ±.01 ±0.1
X.X ±.03 ±0.3
X ±.06 ±1
ANG. DEG. ±.5 ±0.5
FINISH 63 T.C.
THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802-8292. Fax: (650)802-8298.

TITLE
ELECTRICAL ASSEMBLY
MOTION CONTROL

SIZE A1 | DRAWING NO. 11907-0001-0 | REV A
SCALE 1:1 | WT kg | SHEET 1 OF 1

Section 6.2

APPENDIX – NATIONAL INSTRUMENTS GPIB/RS232 CONVERTER DATA SHEETS

GPIB RS-232/485 Controllers and RS-232 Converter

GPIB ↔ Serial Controllers and Converter

- Completely IEEE 488.2 compatible
- 256 KB RAM buffer
- 8 RS-232 or RS-485 data transfer rates up to 38.4 kb/s; hardware handshaking, and the XON/XOFF protocols prevent data loss
- Cable lengths extend GPIB
  - Up to 15.6 m (50 ft.) for GPIB-232CT-A and GPIB-232CV-A
  - Up to 1.2 km (4,000 ft.) for GPIB-485CT-A

NI GPIB-232CT-A, NI-GPIB-485CT-A

- Compatible with RS-422 ports (GPIB-485CT-A)
- NI-488.2 for Windows 3.1/DOS
- Applications
  - Integrate an RS-232/485 instrument into a GPIB system
  - Control a GPIB-based test system from a remote computer via RS-232/485

NI GPIB-232CV-A

- Switch-selectable interface parameters include IEEE 488 address, transfer rate, parity, stop bits, word length, and termination mode
- Special SRQ-ON-EMPTY feature for maximum GPIB performance
- Applications
  - Print from a laptop computer to an IEEE 488 printer
  - Interface an RS-232 device to an IEEE 488 bus system

NI GPIB-232CT-A, NI GPIB-485CT-A

Overview

The National Instruments GPIB-232CT-A and GPIB-485CT-A can turn any computer or terminal with an RS-232 or RS-485 port into a full-function IEEE 488.2 controller. With the flip of a switch, the NI GPIB-232CT-A or NI GPIB-485CT-A can make any RS-232 or RS-485 device appear as a GPIB device. The small size of these controllers makes them ideal for use with laptop computers or other computers that have no internal I/O slots available.

The NAT4882 IEEE 488.2 ASIC implements the full range of GPIB controller functions, including those controller functions required and recommended by IEEE 488.2. All GPIB sequences and operations conform to IEEE 488.2. External DIP switches set the operating mode, the GPIB primary address, and serial port parameters.

Depending on the version, the GPIB-232CT-A and GPIB-485CT-A controllers can accept either AC or DC power input. You can connect either the GPIB-232CT-A or the GPIB-485CT-A to up to 14 GPIB instruments. In addition, when you pair the GPIB-485CT-A with an RS-485 board for the PC, such as the National Instruments PCI-485, you can use it as a cost-effective GPIB extender up to 1.2 km (4,000 ft).

Controller Capabilities

Data Buffer – A FIFO data buffer helps maximize performance. The GPIB-232CT-A and GPIB-485CT-A can continue to accept data from the serial or GPIB port while the other port is busy.

Complete Status Update – The GPIB-232CT-A and GPIB-485CT-A handle both continuous and requested status and error reporting in either symbolic or numeric form.

Symbolic status reporting is useful for direct viewing on a terminal (CMPL for complete, ERR for error, and so on). Numeric status reporting is useful for processing by an application.

Modes of Operation

You can use either controllers in either Serial (S) or GPIB (G) mode. These modes are described using the GPIB-232CT-A as an example.

S Mode – Figure 1 shows the GPIB-232CT-A used in the S mode. In S mode, the device on the serial side of the GPIB-232CT-A is a computer or similar intelligent device.

The GPIB-232CT-A acts as a protocol translator between the serial port and GPIB devices and has complete Talker/Listener/Controller capability. For S mode, you can use a full repertoire of GPIB-related commands and others that manage the serial interface and the GPIB-232CT-A itself.

G Mode – Figure 2 shows the GPIB-232CT-A used in the G mode. In G mode, the GPIB-232CT-A makes a serial device appear as a GPIB Talker/Listener to the Controller. The GPIB-232CT-A recognizes two addresses in G mode – it treats one as its GPIB address and the other as the serial device address. When the GPIB-232CT-A receives its GPIB listen address, it treats the data it receives as a programming message. When the GPIB-232CT-A receives the serial device listen address, it simply passes the data it receives to the serial device. When the GPIB-232CT-A receives its GPIB talk address, it sends out status information. When the GPIB-232CT-A receives the serial device talk address, it sends out the serial data received from the device. You can program the GPIB-232CT-A to assert SRQ under a variety of

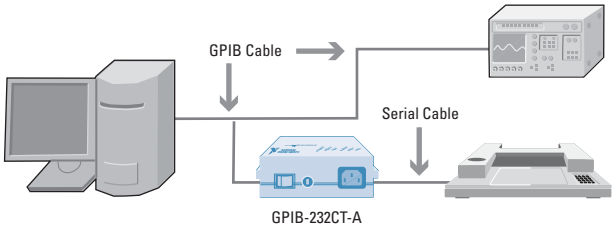


Figure 1. S Mode Application Example

conditions; for example, when it has received any data from the serial device, or when it has received an end-of-string byte from the serial device.

Software – Win32 Compatibility

Native 32-bit compatability with board-level NI-488.2 functions is possible with a Win 32 operating system. For details, refer to the Application Note titled "Board-Level NI-488.2 Software for the GPIB-232CT-A and Windows NT/98/95" (Application Note 130, part number 341585A-01).

Under Windows Me/9x, you can install and use NI-488.2 for DOS to run DOS applications, NI-488.2 for Windows 3.1 to run Win16 applications, and NI-488.2 for Windows 3.1 along with the compatibility release to run Win32 applications.

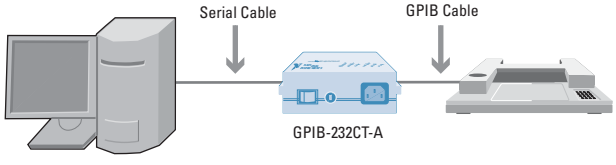


Figure 2. G Mode Application Example

NI GPIB-232CV-A

Overview

The National Instruments GPIB-232CV-A IEEE 488 to RS-232 protocol converter transparently converts data between the two ports without control codes or special commands. The NI GPIB-232CV-A also increases the efficiency of the interface system by isolating a slow device from the faster port using its built-in DMA controller and 256 kb RAM buffer. You can use the GPIB-232CV-A with virtually all PCs.

The GPIB-232CV-A links either a GPIB controller to an instrument with an RS-232 port or a GPIB device to a computer through the computer serial port. For example, the GPIB-232CV-A can interface a GPIB device, such as an IEEE 488 spectrum analyzer, to a computer with an RS-232 port; or it can connect an RS-232 device, such as a printer or plotter, to a GPIB network. Data transfers in either direction are possible at all times.

Depending on the version, the GPIB-232CV-A can accept either AC or DC power input.

Modes of Operation

You can configure the GPIB-232CV-A to run in one of two modes – device mode or controller mode. Device mode configures the GPIB-232CV-A to perform as a GPIB Talker/Listener controlled by another GPIB Controller. Controller mode configures the GPIB-232CV-A as a GPIB Controller that addresses a single GPIB device to talk or listen.

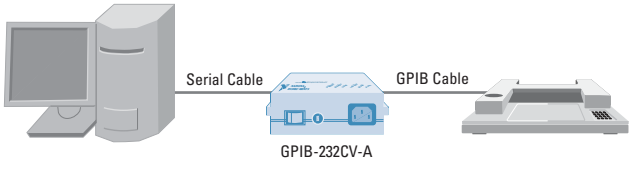


Figure 3. G Mode Application Example

GPIB RS-232/485 Controllers and RS-232 Converter

Ordering Information

GPIB-232CT-A
- GPIB-232CT-A hardware only
  - AC version 776668-0P
  - DC version 776899-Y1
- GPIB-232CT-A and NI-488.2 for Windows 3.1/DOS
  - AC version 776667-0P
  - DC version 776900-Y1

GPIB-485CT-A
- GPIB-485CT-A hardware only
  - AC version 777146-0P
  - DC version 777147-Y1
- GPIB-485CT-A and NI-488.2 for Windows 3.1/DOS
  - AC version 777148-0P
  - DC version 777149-Y1

GPIB-232CV-A
- GPIB-232CV-A hardware only
  - AC version 776669-0P
  - DC version 776898-Y1

P = Power cord type
- 1 = U.S. 120 VAC
- 2 = Swiss 220 VAC
- 3 = Australian 240 VAC
- 4 = Universal Euro 240 VAC
- 5 = North American 240 VAC
- 6 = United Kingdom 240 VAC

Y = Power supply type
- 0 = 115 VAC
- 3 = 230 VAC

Cables

National Instruments recommends you use the following cables with the GPIB-232CV-A/GPIB-232CT-A.

Serial null modem cable (9-pin D-Sub to 9-pin D-Sub)
- 1 m 182238-01
- 2 m 182238-02
- 4 m 182238-04

RS1 cable (9-pin D-Sub to 25-pin D-Sub)
- 1 m 181074-10

GPIB-232CV-A/Mac cable (9-pin D-Sub to Macintosh port, 8-pin DIN)
- 1 m 182514-01

National Instruments recommends you use the following cables with the GPIB-485CT-A.

RS2 cable (9-pin female D-Sub to 9-pin female D-Sub)
- 1 m 183283-01
- 2 m 183283-02
- 4 m 183283-04

BUY ONLINE!

Visit ni.com/info and enter gpib232cta, gpib485cta, and/or gpib232cva.

Specifications

Power Requirements

AC version (50 to 60 Hz)
- 100 to 120 ±10% VAC ..... 5 VA
- 220 to 240 ±10% VAC ..... 5 VA

DC version
- 5 to 13 VDC ..... 700 mA

Physical

Dimensions
- AC version ..... 7.6 by 4.4 by 11.8 cm (3.0 by 1.7 by 4.7 in.)
- DC version ..... 7.6 by 2.8 by 11.8 cm (3.0 by 1.1 by 4.7 in.)

Weight ..... 340.2 g (12 oz)

I/O Connectors

GPIB port ..... IEEE 488 standard 24-pin
Serial port ..... Standard 9-pin male D-Sub

Operating Environment

Temperature ..... 0 to 40 °C
Relative humidity ..... 10 to 90%, noncondensing

Storage Environment

Temperature ..... -20 to 70 °C
Relative humidity ..... 10 to 95%, noncondensing

Noise Emissions

FCC Class A verified (AC version)
FCC Class B verified (DC version)

Compliance

Online at ni.com/hardref.nsf

Serial Port

Full-duplex with optional echo
7 or 8 data bits, 1 or 2 stop bits
Odd, even, or no parity
Baud rates: 300, 600, 1200, 2400, 4800, 9600 b/s; 19.2, 38.4 kb/s

RS-232 Specific

Asynchronous RS-232 EIA level
DTE configuration
XON/XOFF and DTR/RTS/CTS handshake

RS-485 Specific

Asynchronous EIA-485 level
Hardware handshake and XON/XOFF

GPIB-232CV-A GPIB Transfer Rate

GPIB reads into buffer memory ..... Up to 625 kbytes/s

GPIB-232CV-A Buffer Details

C-Mode
- Serial to GPIB ..... 256 KB

D-Mode, small serial buffer
- Serial to GPIB ..... 256 B
- GPIB to serial ..... 256 KB

D-Mode, large serial buffer
- Serial to GPIB ..... 32 KB
- GPIB to serial ..... 224 KB

Section 6.3
APPENDIX – VELMEX VXM-2 MOTOR CONTROLLER SPECIFICATION

VELMEX, INC.

VXM-LIT1
August 20, 2002

VXM Stepping Motor Controller

"Motion Control for Science and Industry"

20+ Years of Stepping Motor Controls

The VXM is a high performance, advanced design stepping motor controller. High reliability, and consistent performance are achieved by these design features:

- Single chip microcontroller (MCU) digitally controls the motor phase switching and all other interface functions (noise sensitive step and direction translation circuitry are eliminated)
- Pulse width modulated timing is preset by the MCU, eliminating error prone analog feedback circuits
- Regulated power supply with a 100 to 240VAC input range assures consistent motor output torque
- 4X oversize motor drives for long life and overload tolerance
- A single VXM can accept and execute commands for operating 4 motors
- Complete Controller/Indexer/Driver/AC Power Supply with RS-232 interface
- Modulated current control drive has less low speed vibration than typical 400 step/rev controllers
- Nonvolatile memory for user program storage
- Small size and low cost
- All cables included, just plug in and run
- External desktop type power supply is UL, CE, CSA, and TUV safety agency compliant
- One and two motor versions. Three and four motor capability with two Controls linked by the VXM bus
- Software compatible with Velmex NF90 and VP9000 Step Motor controllers
- User programmable inputs and outputs
- 10 bit analog input for external sensor, setting speed, or for analog joystick control
- Runs size 17 to 34 step motors rated from 1.2 to 4.7 amps
- Jog, Run, and Stop input buttons on front panel
- Use interactively with a PC or run standalone
- Optically isolated limit switch inputs
- User resettable circuit breaker protected
- Software settable motor power and motor model selection
- Low voltage 24VDC operation
- Energy saving design, automatically de-energizes motors at a standstill, consuming only 1.4 watts
- FIFO buffer to capture motor positions on external trigger
- Coordinated motion with two VXMs
- Complex motion profiles with "continuous index mode"
- Two Year Limited Warranty

Physical: (VXM-1 and VXM-2)
Weight.(VXM-1)...2.6 lbs (1.2 kg)
Weight.(VXM-2)...2.9 lbs (1.3 kg)
Height .....3.27" (83 mm)
Width .....4.37" (111 mm)
Length .....6.89" (175 mm)
Physical: (AC Power Supply)
Weight.....1.0 lbs (0.45kg)
Height .....1.57" (40 mm)
Width .....2.72" (69 mm)
Length .....5.14" (131 mm)

Electrical Requirements:
AC Power Supply..... 100-240VAC 2A 50-60Hz
VXM Controller 24VDC 2.5A
Environmental:
Operating Temperature .... 35°-95° F (2°-35° C)
Relative Humidity..... 10%-90% (non-condensing)
Models/Price:
VXM-1 (one motor version) $640
VXM-2 (two motor version, one motor operates at a time) $785

Availability: In Production

Contact Information:
By Phone: 585-657-6151 and 800-642-6446
By Fax: 585-657-6153
Email: info@velmex.com
On the Internet: www.velmex.com and www.bislide.com
By mail: Velmex, Inc., 7550 State Route 5 & 20, Bloomfield, NY 14469 USA

VXM Command Summary

Most commonly used commands:

F Enable On-Line mode with echo "oFF"
ImMx Set steps to incremental Index motor CW (positive), m= motor# (1,2,3,4), x=1 to 16,777,215
ImM-x Set steps to incremental Index motor CCW (negative), m= motor# (1,2,3,4), x=1 to 16,777,215
R Run currently selected program
C Clear all commands from currently selected program

Motor commands:

ImMx Set steps to incremental Index motor CW (positive), m= motor# (1,2,3,4), x=1 to 16,777,215
ImM-x Set steps to incremental Index motor CCW (negative), m= motor# (1,2,3,4), x=1 to 16,777,215
IAmMx Set Absolute Index distance, m=motor# (1,2,3,4), x= ±1 to ±16,777,215 steps
IAmM0 Index motor to Absolute zero position, m=motor# (1,2,3,4)
IAmM-0 Zero motor position for motor# m, m= 1,2,3,4
ImM0 Index motor until positive limit is encountered, m=motor# (1,2,3,4)
ImM-0 Index motor until negative limit is encountered, m=motor# (1,2,3,4)
SmMx Set Speed of motor (70% power), m= motor# (1,2,3,4), x=1 to 6000 steps/sec. (SAmMx is 100% power)
SmM-x Read and assign analog input value to motor m speed (70% power), x=speed range (**SAmM-x** is 100% power)
AmMx Acceleration/deceleration, m= motor# (1,2,3,4), x=1 to 127.

Program management commands:

PMx Select Program number x, x= 0 to 4
PM-x Select and clear all commands from Program number x, x= 0 to 4
PM Request the number of the current Program
PMAx Program Associate program x in Master to program x in Slave (Linked VXMs start the same time) -x or x =255 is disable
PMA Request the current program associate number

Special looping/branching commands:

L0 Loop continually from the beginning or Loop-to-marker of the current program
LM0 Sets the Loop-to-marker at the current location in the program
LM-0 Resets the Loop-to-marker to the beginning of the current program
Lx Loop from beginning or Loop-to-marker x-1 times (x=2 to 65,535), when the loop reaches its last count the non-loop command directly preceding will be ignored
L-x Loop from beginning or Loop-to-marker x-1 times, alternating direction of motor 1, when the loop reaches its last count the non-loop command directly preceding will be ignored
LAx Loop Always from beginning or Loop-to-marker x-1 times (x=2 to 65,535)
LA-x Loop Always from beginning or Loop-to-marker x-1 times, alternating direction of motor 1
LM-2 Loop once from beginning or Loop-to-marker reversing index direction of motor 2
LM-3 Loop once from beginning or Loop-to-marker reversing index direction of motor 1 and motor 2
Jx Jump to the beginning of program number x, x= 0 to 4
JMx Jump to the beginning of program number x and come back for More after program x ends, x= 0 to 4

Pausing and input output commands:

Px Pause x tenths of a second, (x=0 to 65,535, 10 µsec pause when x=0) tenths of a millisecond when x is negative
PAx Pause x tenths of a second Altering output 1 high for duration of the pause, tenths of a millisecond when x is negative
U0 Wait for a "low" on user input 1
U1 Wait for a low on user input 1, holding user output 1 high while waiting
U2 Enable Jog mode while waiting for an input
U3 Disable Jog mode while waiting for an input
U4 User output 1 "low" (reset state)
U5 User output 1 high
U6 Send "W" to host and wait for a "G" to continue
U7 Start of Continuous Index with 10 µsec pulse on output 2
U77 Start of Continuous Index with no output
U8 Start of Continuous Index sending "@" to the host
U9 End of Continuous Index with autodecel to stop
U91 End of Continuous Index with auto-generate a deceleration Index as next command
U92 End of Continuous Index using next Index for deceleration to stop
U99 End of Continuous Index with instantaneous stop
U13 Wait for a front panel button to jump to a program or continue: "Motor 1 Jog -" button to jump to program #1, "Motor 1 Jog +" button to jump to program #2, "Run" button to proceed in current program.
U14 User output 2 low (reset state)
U15 User output 2 high
U16 Optional User output 3 low (reset state)
U17 Optional User output 3 high
U18 Optional User output 4 low (reset state)
U19 Optional User output 4 high
U23 Wait for a front panel button to jump to a program and come back, or continue: "Motor 1 Jog -" button to jump and return to program #1, "Motor 1 Jog +" button to jump and return to program #2, "Run" button to proceed in current program
U30 Wait for a low to high transition on user input 1
U31 Wait for a low to high transition on user input 1, holding user output 1 high while waiting
U32 Wait for "Motor 1 Jog -" button to be pressed on front panel with debouncing
U33 Wait for "Motor 1 Jog +" button to be pressed on front panel with debouncing
U50 Wait for a low and high on user input 1 with debouncing for a mechanical push-button switch
U51 Wait for a low and high on user input 1 with debouncing for a mechanical push-button switch, holding user output 1 high while waiting
U90 Wait for a low to high on the Run button or connection I/O,4 with debouncing for a mechanical push-button switch

Operation commands:

Q Quit On-Line mode (return to Local mode)
R Run currently selected program
N Null (zero) motors 1,2,3,4 absolute position registers
K Kill operation/program in progress and reset user outputs
C Clear all commands from currently selected program
D Decelerate to a stop (interrupts current index/ program in progress)
E Enable On-Line mode with echo "on"
F Enable On-Line mode with echo "off"
G Enable On-Line mode with echo off Grouping a <cr> with "^", ":", "W", "O" responses; Also Go after waiting or holding
H Put Controller on Hold (stop after each command and wait for go)
! Record motor positions for later recall with "x","y" commands
res Software reset controller
del Delete last command

***Status request commands*:**

V Verify Controller's status, VXM sends "B" to host if busy, "R" if ready, "J" if in the Jog/slew mode, or "b" if Jog/slewing
X Send current position of motor 1 to host (Motor can be in motion)
Y Send current position of motor 2 to host (Motor can be in motion)
Z Send current position of motor 3 to host (Motor must be stationary)
T Send current position of motor 4 to host (Motor must be stationary)
x Send last 4 positions of motor 1 to host that were captured by the "!" command or Input 4 trigger
y Send last 4 positions of motor 2 to host that were captured by the "!" command or Input 4 trigger
M Request Memory available for currently selected program
Request the number of the currently selected motor
***** Request the position when the last motor started decelerating (shows position when "D" command or Stop/User input 4 used)
? Read state of limit switch inputs (8 bit binary value)
~ Read state of User Inputs, Motor 1 and 2 Jog Inputs (8 bit binary value)
@ Read user analog input value
B Read Backlash compensation setting
O Read Indicate limit switch setting
getDx Read mode/version
getDA Read Joystick Deadband setting
getjmM Read first range Jog Speed for motor m. **getjAmM** for Joystick range setting
getJmM Read second range Jog Speed for motor m. **getJAmM** for Joystick range setting
getLmM Read mode of limits for motor m
getMmM Read motor type/size selected for axis m
getPmM Read "Pulse Every x # Steps" value for axis m
getI Read operating mode of user inputs
lst List current program to host (ASCII text)

Commands for two controls connected by VXM bus:

(i3,i1...) Combine Index commands to run simultaneously on two VXM controllers connected by VXM bus
[i1,i2...] Send data to Slave through Master

***Jog mode commands*:**

D Read motor position (Digitize)

Special function and setup commands:

Bx Backlash compensation, on when x=1, off when x=0
Ox Indicate limit switch Over-travel to host, off when x=0, VXM sends "O" when x=1 and hit limit, x=3 program stops too
setDMx Set VXM/VP9000 or NF90 emulation modes, and other operating parameters
setDAx Set Joystick Deadband value
setjmM Set first range Jog Speed for motor m. **setjAmM** for Joystick range setting
setJmM Set second range Jog Speed for motor m. **setJAmM** for Joystick range setting
setLmMx Set limit switch mode for axis m
setMmMx Set axis m for motor type/size x. Also sets default (jog/joystick) motor power to 70%. **setMAmMx** is 100% power
setPmMx Set "Pulse Every x # Steps" on output 2 for axis m
setIx Set operating mode of inputs
setBx Set RS-232 Baud rate (9=9600, 19=19200, 38=38400)

Memory save commands

rsm Run save memory (saves setup/ program values to nonvolatile memory)

Legend: **New Commands for VXM not available on VP9000 or NF90, Different input/output/range/additional values from VP9000, Different command/ function for NF90 mode**

Nf90 emulation mode:

ImM0 Index motor m to absolute zero position
L-0 Sets the Loop-to-marker at the current location in the program
U2 Disable user output when pausing
U3 Enable output when pausing (reset state)

Acceleration/deceleration values will be internally doubled to match NF90's 2x ramp rate
VP9000 Commands not supported by VXM: **U10, U11, U12, U22, U40, U41, U60, U61, U70, U71, U72, U73, { }, %, &**

Velmex Controls Comparision

Feature	VXM	VP9000***	NF90***
Addressable Axes/ Control	1,2,3*,4* * Powered by 2nd VXM linked with VXM bus	1,2,3,4	1,2,3
Motor Compatibility	Size 17 to size 34 1.2 to 4.7 amp	Size 17 to size 34 1.2 to 5 amp	Size 17 to size 34 0.8 to 4.7 amp
Motor output torque as percent of NF90 (M091 Motor)	185% @ 0.2 rev/sec 200% @ 5 rev/sec 340% @ 10 rev/sec	185% @ 0.2 rev/sec 290% @ 5 rev/sec 340% @ 10 rev/sec	100%
Steps/ revolution	400	400	400
Speed Range (steps/sec)	1 to 6000	1 to 8000	1 to 6000
Program Storage (memory type)	5 (RAM/ FLASH)	31 (NVRAM)	1 (RAM)
Preset range for user “Pulse Every x # Steps”	0 to 32,767	Not available	Not available
User Inputs	Run (Active Low) In 1** (Active Low) In 2** (Multifunction) In 3** (Multifunction) In 4** (Stop Interrupt) In A** (Analog)	Run (Active High) In 1 (Active High) In 2 In 3 (Wait Interrupt) In 4 (Stop Interrupt) Reset Encoder	Run (Active High) In 1 (Active High)
User Outputs	Out 1** Out 2** Optional Out 3** Optional Out 4** +5VDC** ** x2 for Linked VXMs	Out 1 Out 2 Encoder +5VDC	Out 1 +5VDC
Other Inputs	AC/DC Power Limit Switch (Optically Isolated)	AC Power Limit Switch (TTL logic)	AC Power Limit Switch (TTL logic)
Other Outputs	Motor (6 wire Unipolar)	Motor (6 wire Unipolar)	Motor (6 wire Unipolar)
User Interfaces	RS-232 (Tx, Rx, Gnd) Run,Stop, and Jog Keys Opt. Speed Pot. Analog Joystick Remote Jog Opt. Program Sel. Switch	RS-232 (Tx, Rx, Gnd) Keyboard LCD Display Remote Jog	RS-232 (Tx, Rx, Gnd) Remote Jog
RS-232 Configuration Default Baud Rate Maximum Baud Rate	8 Data, No Parity, 1 Stop 9600 38,400	7 Data, Even Par, 2 Stop 9600 9600	7 Data, Even Par, 2 Stop 9600 9600
Size (in^3)	98 for VXM 22 for Power Supply	632	421

*** Previously manufactured step motor controllers being replaced by the VXM

Section 6.4
APPENDIX – GMW MOTION CONTROL PARTS LIST

8/18/2005 # Parts List For GMW MOTION CONTROL

MFG. PART#	DESCRIPTION	GMW DWG#	MANUFAC.	QTY			
Motion Stage							
B4836TS	ROTARY STAGE, 36:1 gear ration	11907-0006-0	VELMEX	1			
	(VELMEX Part Number 3-812 0.025DEG C/step)						
3-934R	ZERO REFERENCE SWITCH	11907-0006-0	VELMEX	1			
MAXY Series	XY TABLE, St 1mm leadscrew	11907-0006-0	VELMEX	1			
	(VELMEX Part number MAXY4009K1-S4)						
3-8515	Limit switch, ADJUSTABLE (pair)	11907-0006-0	VELMEX	2			
5-0981	STEPPER MOTOR, Double Shaft	11907-0006-0	VELMEX	3			
17907-0006-0	ADAPTER PLATE, XY TABLE /ROTARY STAGE	11907-0006-0	GMW-Am Proto	1			
17907-0007-0	ADAPTER PLATE, XY ROTARY STAGE/MAGNET	11907-0006-0	GMW-Am Proto	1			
CN11-5	HAND WHEEL, ALUMINUM	11907-0006-0	BERG	3			
10907-0013-0	LABEL, T-AXIS [ANGLE]	11907-0006-0	METAL IMAGE	1			
10907-0011-0	LABEL, X-AXIS	11907-0006-0	METAL IMAGE	1			
10907-0012-0	LABEL, Y-AXIS	11907-0006-0	METAL IMAGE	1			
10907-0015-0	LABEL, IDENTIFICATION, STAGE	11907-0006-0	METAL IMAGE	1			
Controller							
776898-01	RS232/GPIB CONVERTOR	11907-0001-0	NI	1			
4-2102	CONTROLLER, STEPPER MOTOR	11907-0001-0	VELMEX	2			
4-2122	CABLE, BUSSING	11907-0001-0	VELMEX	1			
SP18579	CABLE, RS-232, 9PIN, M/F, 2FT, STRAIGHT THROUGH	11907-0001-0	L-COM	1			
CIB24XC	GPIB PLUG EXTENDER	11907-0001-0	L-COM	1			
CIF24-4M	CABLE, GPIB, 4M	11907-0001-0	L-COM	1			
HCC15-3A+	POWER SUPPLY, DUAL 12V@3.4A	11907-0001-0	CONDOR	1			
17907-0003-0	BASE PLATE	11907-0001-0	GMW-Am Proto	1			
12907-0001-0	FRONT PANEL	11907-0002-0	GMW-Am Proto	1			
12907-0002-0	REAR PANEL	11907-0003-0	GMW-Am Proto	1			
17907-0004-0	CONTROLLER MOUNTING BAR	11907-0001-0	GMW-Am Proto	4			
17907-0005-0	GPIB CONVERTOR MOUNTING PLATE	11907-0001-0	GMW-Am Proto	1			
14B035	CASE, RACK MTG 3U [with handles]	11907-0001-0	ELMA	1			
14Y135-10	COVER PLATE KIT GREY	11907-0001-0	ELMA	1			
63-068	TAPPED STRIP 2X6, M3 HOLES	11907-0001-0	ELMA	4			
63-172	EARTHING KIT	11907-0001-0	ELMA	1			
63-027	BASE PLATE	11907-0001-0	ELMA	6			
1904-12	SCREW, M4x10 LOW PROFILE HD	11907-0001-0	ELMA	12			
1904-35	FRONT PANEL SCREWS (ALSO FOR REAR PANEL)	11907-0002-0	ELMA	8			
63-119	SCREW RETAINERS (ALSO FOR REAR PANEL)	11907-0002-0	ELMA	8			
222-503	SPACER, M4X25 BRASS R-S	11907-0001-0		4			

RN-4-250A	SPACER, 6.35X6.25 NYLON SPC	11907-0001-0		4			
239001	FUSE LINK 1.0A SLO BLO LITTLEFUSE	11907-0001-0		2			
239002	FUSE LINK 2.0A SLO BLO LITTLEFUSE	11907-0001-0		2			
7043020305	POWER CORD SET, PANEL COMPONENT (USA)	11907-0001-0		1			
10907-0004-0	LABEL, MASTER CONTROLLER	11907-0001-0	METAL IMAGE	1			
10907-0005-0	LABEL, SLAVE CONTROLLER	11907-0001-0	METAL IMAGE	1			
10907-0006-0	LABEL, CONTROLLER	11907-0001-0	METAL IMAGE	1			
10907-0001-0	LABEL, IDENTIFICATION, CONTROLLER	11907-0002-0	METAL IMAGE				
10907-0002-0	LABEL, INPUT/OUTPUT	11907-0003-0	METAL IMAGE	1			
10907-0003-0	LABEL, SPECIFICATION	11907-0003-0	METAL IMAGE	1			
82710070	POWER SWITCH	11907-0002-0	INTERPOWER	1			
83544010	POWER FILTER/VOLTAGE SELECTOR MODULE	11907-0003-0	INTERPOWER	1			
CGP-3	GROMMET EDGING STRIP	11907-0003-0	SPC	A/R			

Optional Z Stage:

3-8515	LIMIT SWITCH	11907-0006-0	VELMEX	1			
5-0981	STEPPER MOTOR, Double Shaft	11907-0006-0	VELMEX	1			
MA Series	Linear Slide, Std 1mm leadscrew	11907-0006-0	VELMEX	1			
	(VELMEX Part:MA4006K1-S4)	11907-0006-0					
CN11-5	HANDWHELL, ALUMINUM	11907-0006-0	BERG				
17907-0008-0	ADAPTOR PLATE, Y SLIDE TO Z SLIDE	11907-0006-0	GMW-Am Proto	1			
17907-0009-0	ADAPTOR PLATE, Z SLIDE TO ROTARY STAGE	11907-0006-0	GMW-Am Proto	1			
17907-0010-0	SPACER BAR, Z SLIDE, pair	11907-0006-0	GMW-Am Proto	1 pair			
10907-0014-0	LABEL, Z-AXIS	11907-0006-0	METAL IMAGE	1			

Fasteners

	SHCS FLAT HD, 10-32 X 5/8" S/S	11907-0006-0		4			
	SHCS FLAT HD, 10-32 X 1/2" S/S	11907-0006-0		4			
	SHCS 1/4 X 3/4" S/S	11907-0006-0		3			
	SHCS M3 X 8 S/S	11907-0006-0		4			
	WASHER, FLAT M3 S/S	11907-0006-0		4			
	WASHER, INTERNAL LOCK M3 S/S	11907-0006-0		4			
	SHCS, 10-32 X 5/8" S/S	11907-0006-0		4			
	SHCS, 10-32 X 1 1/8" S/S	11907-0006-0		4			
	SCREW, 4-40 X 3/16" PAN HD S/S	11907-0001-0		4			
	WASHER, M4, INTERNAL LOCK S/S	11907-0001-0		8			
	WASH, M4, FLAT S/S	11907-0001-0		8			
	NUT, HEX M4 S/S	11907-0001-0		8			
	SCREW, M3 X 16 PAN HD S/S	11907-0001-0		4			
	SCREW, M4 X 8 PAN HD S/S	11907-0001-0		8			
	SCREW, M4 X 12 PAN HD S/S	11907-0001-0		12			